LETTERS TO THE EDITOR

Prompt publication of brief reports of important discoveries in physics may be secured by addressing them to this department. Closing dates for this department are, for the first issue of the month, the twenty-eighth of the preceding month; for the second issue, the thirteenth of the month. The Board of Editors does not hold itself responsible for the opinions expressed by the correspondents.

Scattering of Light By Kerr Cell

The amount of light from a mercury arc scattered at small angles in its passage through a parallel plate condenser, containing water as its dielectric, was investigated. The intensity of the light scattered at small angles to the direction of the directly transmitted beam, when a high frequency field of one meter approximately was impressed on the plates of the condenser by a short wave-length oscillating circuit, was found to be comparable in intensity to the radiation falling on the cell. The spectrograms taken in the ultraviolet region from 3000A to 2500A of the light scattered at angles from 1° to −1° with respect to the direction of the primary beam indicated that all the light passing through the cell had been scattered. For lower frequencies, order of 6 meters wave-length, the amount of scattered light depended on the wave-length of the light.

The light scattered by the Kerr cell showed a change in wave-length towards the red of 0.06A, the same as that reported by the writer (Phys. Rev. **33,** 279 and 640, 1929) for certain lines of the mercury and iron arc, respectively, when the high frequency field impressed on the cell had a wave-length of 6 meters. All the mercury lines, so far observed, 4358, 5460 and 5769 respectively, show this red displacement when the high frequency field impressed on the Kerr cell has a wave-length of one meter.

The observations on the light scattered at small angles by the cell indicate that only the light which has been scattered by the cell suffers the displacements towards the red. The difference in the behavior of the lines for lower frequencies of the field impressed on the cell, is due to the marked difference in the ratio of the intensity of the scattered light to the primary beam, entering the cell, for the different lines.

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September 14, 1929.

The Symmetry of Nuclear Wave Functions

Dr. F. Rasetti, working at these laboratories, has clearly shown by his experiments on the Raman effect in nitrogen that the even rotational states of the nitrogen molecule have a greater weight than the odd rotational states in contradistinction to the behavior of the hydrogen molecule. Heitler and Herzberg[1] have pointed out that this is a very surprising result because the nitrogen nucleus contains an even number of protons and an odd number of electrons so that, no matter what statistics protons satisfy, we should expect the wave functions for nitrogen nuclei to be antisymmetric in those nuclei. Assuming that Dennison's theory of the rotational specific heat of hydrogen and Hori's analysis of the band spectrum of hydrogen prove that hydrogen nuclei have antisymmetric wave functions there is apparently no path to take but suggest, as Heitler and Herzberg have done, that the symmetry properties of nuclei do not depend upon those of the electrons supposedly contained in them. This would introduce many theoretical difficulties.

[1] Heitler and Herzberg, Naturwissenschaften **34,** 673 (1929).

However, the writer has shown[2] in a brief note that a complete analysis of the symmetry properties of symmetrical diatomic molecules shows that Dennison's theory and Hori's experimental work are evidences that protonic wave functions are symmetric, that is, protons satisfy the Einstein-Bose statistics. If this is so, the same analysis applied to the nitrogen molecule, making the natural assumption that the nitrogen nuclei satisfy the Fermi-Dirac statistics on account of the odd electron, leads one at once to expect Dr. Rasetti's experimental results. As a matter of fact the writer predicted this result to Dr. Rasetti before he knew of the results of the photographs.

Perhaps there is one confusing point in the paper showing that protonic wave functions are symmetric. ψ_e as defined in that paper was stated to be unchanged by simultaneously interchanging the nuclei and electrons of the molecule there considered. The confusion seems to arise from the apparent difficulty in choosing the coordinate system of rest of the weak magnetic field quantizing the spins of the electrons. Evidently the magnetic field can be specified in any coordinate system but it must be regarded as a moving field in all systems but those at rest to the system in which the electronic coordinates are specified. In this case, such a coordinate system is determined by the nuclei and rotates with the molecule. A little consideration will show that by interchanging the nuclei, the coordinate wave functions of the electrons in a basic Σ_1 state of a molecule are unchanged while the signs of the spins are changed because the quantizing magnetic field is first regarded in a positive direction and then in a negative direction. The interchange of the electrons which also involves the spins then restores the wave function to its original sign. Quantizing the electronic spins in a field fixed in space, that is a moving field as far as the molecule is concerned, will for an individual molecule sometimes find the electron spins parallel and sometimes antiparallel. But for an assembly of molecules it will have an equal probability of finding electron spins oriented with or against the field.

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September 17, 1929.

[2] Cassen, Proc. Nat. Acad. Sci. **15,** 29 (1929).

The Heat of Dissociation of Oxygen and of Nitrogen

Two communications in the Physical Review of September 1 seem to call for brief comment. The first is a letter by L. S. Kassel (page 817) in which, from work on the decomposition of ozone, it is deduced that the heat of dissociation D for O_2 lies between 5.0 and 5.5 volts, as contrasted with the Birge and Sponer value of 7.0 volts. In a paper to be read September 24 at a symposium of the Faraday Society, I am presenting a new method for extrapolating vibrational energy curves of molecules (ω_n:n) in cases where these are not linear. Using new data by Rasetti and by Fesefeldt, I find the ω_n:n curve for the normal state of O_2 is definitely *not* linear and cannot give value of D as large as 7.0 volts. From this it follows that molecules in the upper "B" level of O_2 dissociate into one excited and one normal atom, in agreement with Herzberg's theoretical remarks, and that the Birge and Sponer value of 7.0 volts is too large by just the amount of this atomic excitation. My extrapolation indicates that D should be between 5.6 and 6.5 volts, with 6 volts as a most probable value. The resulting atomic excitation, one volt, is in conflict with values of about 2 volts, calculated by Bowen and by Kaplan (Phys. Rev. **33,** 638 1929) for the ^1D metastable level of the oxygen atom. Hence it may be said that the correct value of D for O_2 is at the moment rather uncertain.

The second communication is by L. A. Turner and E. W. Samson (page 747), in which the 0–1 negative band of nitrogen is found to be excited at 19.0 volts, in contrast to Sponer's value of 19.6 volts. These writers quote me as obtaining 3.9 volts for the D of the upper (excited) level of N_2^+. I gave 3.9 volts as an upper limit, not as a most probable value. Using the new method of extrapolation I now find 3.7 ± 0.1 volts as the most probable value. This is discussed in my Faraday Society paper. The well-known process used by Turner and Samson then gives 8.84 volts for the D of N_2, if Sponer's 19.6 volts is correct, or 8.24, if their new 19.0 volt value is correct. Turner and Samson note that if